during an irregularly distributed two-thirds of the time and mostly over the northern part of the Gulf. For the other third of the period the center was over Bering Sea. Lows descended into western Canada from this region on the 1st, 5th, 11th, 15th, 17th, 20th, and 27th. The lowest observed land-station pressure for the month was 28.86 inches, at Kodiak on the 26th. The minimum recorded by a vessel at sea was 28.92 inches, on board the Japanese S. S. *Alaska Maru* in 44° 21′ N., 147° 13′ W., on the 29th. On the same date the American S. S. *Oduna*, in latitude 55° 51′ N., longitude 145° W., had a barometer reading of 28.97. These instances indicate the great extent of the area covered by very low pressure.

The eastern North Pacific HIGH was best established during the first 20 days of April. Thereafter it was considerably broken up, during the last five days largely by the southward swing of the Aleutian cyclone from the Gulf of Alaska.

Pressure at Dutch Harbor averaged 0.16 inch below normal during the first half of the month and 0.19 inch above during the last half. For the month (29 days) the average pressure, based on p. m. observations, was 29.86 inches, or 0.01 inch above normal. The highest pressure, 30.40, was recorded on the 17th and 20th; the lowest, 29.16, on the 3d. The average pressure at Midway Island was 30.11 inches, or 0.02 inch below normal. The highest reading, 30.30, was recorded on the 26th; the lowest, 29.86, on the 30th. At Honolulu pressure was continuously below normal from the 3d to the 23d, the average daily departure (p. m. observations) being −0.09 inch. The average pressure for the month was 30.01 inches, or 0.05 inch below normal. The highest reading, 30.14, was recorded on the 29th; the lowest, 29.85, on the 6th.

Aside from the storm conditions previously noticed, it is observed that a greater part of the northern steamship routes had more gales on the 1st, 2d, and 3d than on any other day or period of days during the month. These gales did not as a rule exceed 8 or 9 in force, but they were accompanied by frequent snow squalls in higher latitudes and raised high seas both east and west of the 180th meridian.

The American S. S. *West Cayote*, Capt. L. Johnson, bound from Portland toward Yokohama, encountered rougher weather probably than any other vessel making a trans-Pacific voyage in April. From the 1st to the 10th, or during most of the westward passage, she passed through a succession of westerly to northerly gales, which did not, however, exceed 9 in force. Her lowest observed pressure was 29.01 inches in 52° 17′ N., 163° 05′ W., on the 3d.

There was little storm activity reported for the greater body of the ocean from the 10th to the 25th. The maximum number of stormy days occurred over and to the southward of the Gulf of Alaska, as might be inferred from the greater prevalence there of the Aleutian cyclone, especially during the last week. This cyclone reached its peak of severity on the 29th, at which time the S. S. *Alaska Maru* experienced her lowest pressure, as already noted, and also sustained a west-southwesterly wind of hurricane force from 4 p. m. until midnight, near 44° N., 147° W. This was the only gale of the month, so far as known, to exceed 10 in force.

Fog, especially in east longitudes, along the sailing routes, showed a decided increase in percentage over that of March. It was observed along practically the entire China coast on the 10th, and in the neighborhood of Shanghai continued until the 16th. Fog also occurred on several days along the American coast, being noted from Puget Sound southward to near Acapulco.

DETAILS OF THE WEATHER IN THE UNITED STATES

GENERAL CONDITIONS

By ALFRED J. HENRY

A warm dry month on the Pacific coast, also warm in the great interior valleys; elsewhere the temperature was close to the normal. More than the normal precipitation in Atlantic coast States and in some of the Gulf States, also in the upper Mississippi Valley. See the inset on Chart IV. The usual details follow.

CYCLONES AND ANTICYCLONES

By W. P. DAY

The movement of the low-pressure areas during the month of April, 1924, was even more erratic than usual for a month which has long been characterized by halting, undecided, and abnormal storm movements. One storm, which developed over Nevada on the 22d, after moving eastward in the normal manner to northwestern Missouri, turned northward and northwestward and finally dissipated over northeastern Montana. In this case the air flow within the LOW was diverted by the intrusion to the east of a large area of high barometric pressure from the Hudson Bay region. A large number of the low-pressure areas had the so-called trough formation in which the point of lowest barometer is a rather indefinite and shifting phenomenon. One of the most severe storms of the month on the Atlantic coast suddenly developed in the southern end of one of these troughs during the 6th in the vicinity of the Virginia Capes, moved northeast to New England, and thence eastward into the Atlantic.

FREE-AIR SUMMARY

By V. E. JAKL, Meteorologist

The average free-air conditions over that portion of the country represented by aerological stations were practically normal in all respects. This is evidenced by Tables 1 and 2, from which it will be noted that the departures from the normal were slight for all elements, although there were a few exceptions. Such exceptions were plausibly accidental rather than real, owing to the circumstance of observation. As kite flights are dependent upon suitable wind and weather, observations by means of them can not be carried on even to moderate altidudes with the regularity characteristic of surface meteorological work. The scattered departures of apparently decided value noted in Tables 1 and 2 need not therefore merit other than passing notice.

Such slight temperature departures as recorded in the general averages are in close agreement geographically—also in character and amount—with the surface departures that appear on Chart III. Inferentially, the causes contributing to the observed average temperatures on the ground extended aloft to the upper limit of observation. For example, the principal periods of cool weather east of the Rocky Mountains, in so far as they are revealed in aerological records, occurred on the 1st–2d, 9th–10th, and 17th–18th. Kite flights made at stations

that were successively within the influence of the HIGHS of which these cool waves were attendant features invariably showed temperatures below normal throughout the vertical column of air sounded. This is in distinction to the common effect of cold-wave HIGHS of the winter months, which frequently, particularly in their earlier stages, cause marked falls in temperature in the lower levels only. Days with temperature above normal were not quite so well defined into periods, nor in scope of area covered by aerological stations, but in most cases the record of kite flights on warm days also showed parallel vertical temperature departure; i. e., a positive departure at all levels. The most conspicuous examples of abnormally warm winds of considerable depth and covering an extended area, are shown by the records of Broken Arrow, Drexel, and Ellendale, on the 15th and 24th. On both dates these stations were in the front of a well-defined trough of low pressure.

The month can be considered a normal one only from the standpoint of the average values as shown in the appended tables, inasmuch as there was frequently a marked tendency to rapid development of threatening weather. To this feature of the month, among other abnormalities in the sequence of weather conditions (see other sections of this REVIEW), can be attributed some observations made at a number of stations on scattered dates under rather unusual circumstances. At two stations, Ellendale and Royal Center, flights were made in threatening weather that resulted in portions of the steel kite line being destroyed by lightning or overcharge of static. The following extract is taken from the report of the Ellendale station: "On April 4, with six kites and 6,500 meters of wire out, a thunderstorm developed suddenly. As much speed as possible was made in reeling in, and it was not until we had reeled in to 3,500 meters that the lightning struck the wire. In this instance the kite wire was not fused, but only burned and distempered. This weakening of the wire was followed by a breakaway. The two men making this flight were standing near the reel, but not touching it, when the lightning struck." On this date Ellendale was in a position midway between a LOW to the southwest and a HIGH to the northeast, with winds that may be said to be appropriate to that position; i. e., the wind veered from east on the ground to southwest at 3,000 meters, and to west at the altitude of the A. St. clouds at 4,800 meters. The record shows that at first the temperature rose and fell irregularly from the ground to 1,700 meters, above which there was an unbroken lapse rate exceeding the adiabatic for saturated air, and a regular increase in humidity, the lowest temperature, and a humidity of nearly 100 per cent being recorded at 4,000 meters, the upper limit of observation. Later, or about the time the discharge took place, humidity had increased to 100 per cent throughout the column of air above about 2,000 meters, and St. Cu. clouds had developed. In this region, above 2,000 meters, convection evidently occurred causing precipitation which in turn caused the high electric charge, the previously dry air in this region needing only the bringing in of moisture to make the existing lapse rate effective to cause convection. No appreciable rain fell, however, until after the maximum temperature had been attained in the lower levels, and the inversions obliterated, after which the lapse rate was adiabatic or more down to the ground.

The following report from Royal Center tells of a somewhat similar experience at that station: "Lightning struck the kite wire on the 18th and vaporized 1,300 meters. No one was injured, except that the men on kite work complained of injury to their eyes, which was noticeable only several hours after the occurrence." In this instance, Royal Center was differently situated with respect to pressure distribution than was the case at Ellendale on the 4th; also the temperature conditions were different. The unstable condition causing the thunderstorm appeared to be due mainly to falling temperature aloft and sustained temperature below. On the date in question Royal Center was under the influence of a LOW central over Ontario. Temperatures aloft had fallen progressively since the 16th, until on the 18th they were much below normal at altitudes above 1,000 meters. The winds aloft were WSW., indicating the transport of cold air from the rear of the LOW, while SW. winds sustained the temperature near the ground. The circulation aloft had been effective in transporting the cold air from regions far to the west and northwest without material gain in temperature, as the preceding 30 hours' record showed temperatures only about 2° C. lower over Drexel and 5° C. lower over Ellendale than at corresponding levels over Royal Center on the 18th. From the following table it is apparent, both from the lapse rate and the humidity, that convection vigorous enough to cause thunderstorms was probably operative only below 2,800 meters, and that the actuating cause was the veering of the surface wind from SW. to WNW. and W. and the rise in pressure usually attending such change in direction.

Meteorological conditions over Royal Center, Ind., on April 18, 1924

Time	Altitude, meters	Temperature, °C.	$\frac{\Delta T}{100\ m.}$	Humidity, per cent	Wind direction	Wind velocity, m. p. s.
12:36	4,122	−16.2	0.57	41	WSW.	29
1:24	2,827	−8.8	.66	94	WSW.	17
1:55	1,249	1.6	.94	85	SW.	16
2:07	Surface	11.0		72	W.	7

A diurnal series of observations at Broken Arrow was interrupted on the night of the 28th–29th by the rapid development of the storm area that appeared central over Kansas on the morning of the 29th, and caused severe thunderstorms in its wake thence east to the coast. Some of the conditions attending the rear of the squall line of this storm are shown in the following table, which gives the upper-air temperatures and winds that prevailed soon after the squall line had passed Due West on the 30th:

Meteorological conditions over Due West, S. C., on April 30, 1924

Time	Altitude, m. s. l., meters	Temperature, °C.	Humidity, per cent	Wind direction	Wind velocity, m. p. s.
1:24	Surface	23.2	48	W.	18
1:31	651	17.4	57	W.	20
1:38	1,406	10.3	84	W.	16
1:59	1,976	5.7	90	WSW.	24
2:05	2,178	4.1	78	W.	27
2:08	2,274	7.3	49	W.	27
2:50	2,607	5.2	25	W.	24
3:10	2,621	4.5	29	W.	22
3:47	2,711	3.6	41	W.	21
4:22	2,738	0.5	49	W.	23
4:38	2,739	0.2	78	W.	22
5:10	2,018	4.4	93	W.	19
5:29	1,385	9.7	93	W.	19
5:44	716	16.4	58	W.	17
5:50	Surface	21.4	52	W.	10

A severe squall occurred at Due West and tornadoes elsewhere in South Carolina a short time before this observation was taken. While it will be noted that the temperature aloft was falling with time, and the lapse rate increasing to a pronounced degree—probably exceeding the lapse rate prevalent at time of precipitation—the weather nevertheless was clearing while the observation was in progress. The record of uniform wind direction with altitude and the fact of rapidly rising pressure indicated that the "cold front" condition of precipitation had passed and high pressure supervened.

Pilot-balloon observations showed but few exceptions in the high altitudes to the normal wind movement from a general westerly direction. The only instance over an extended area of winds aloft having a decided easterly component occurred on the 26th and 27th, the reporting stations having been Ithaca, Lansing, and Washington. On these dates the HIGH approaching from Ontario had attained its maximum depth over the northeastern portion of the country, and the stations mentioned were in its influence. The directions reported were approximately those indicated by the surface isobars, it being characteristic of Hudson Bay HIGHS to show east component winds on their southern side.

A northeast wind in the upper levels extending to 6,000 meters was reported from San Francisco on the 7th, which was then included in a weak LOW, with a pronounced HIGH to the north. The wind ranged from southwest near the ground to southeast at 1,000 meters, above which it backed abruptly to northeast. The influence of the LOW, which caused no appreciable precipitation, apparently extended to only about 1,000 meters, above which the HIGH dominated. In connection with the fact that northern California was under the influence of persistent Pacific HIGHS during the month, to which condition has been ascribed the dryness of the month over that section (see San Francisco forecast district, this REVIEW), it is worthy of note that the resultant winds over San Francisco were northerly to northwesterly at all altitudes.

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during April, 1924*

TEMPERATURE (° C.)

Altitude, m. s. l. (meters)	Broken Arrow, Okla. (233 meters)		Drexel, Nebr. (396 meters)		Due West, S. C. (217 meters)		Ellendale, N. Dak. (444 meters)		Groesbeck, Tex. (141 meters)		Royal Center, Ind. (225 meters)	
	Mean	Departure from 6-year mean	Mean	Departure from 9-year mean	Mean	Departure from 4-year mean	Mean	Departure from 7-year mean	Mean	Departure from 6-year mean	Mean	Departure from 6-year mean
Surface	16.0	+0.7	11.4	+2.7	15.8	−1.3	5.4	+0.2	17.3	−0.9	11.2	+0.3
250	15.9	+0.7			15.5	−1.2			16.5	−1.0	10.9	+0.2
500	14.2	+0.8	10.6	+2.6	13.6	−0.8	5.1	+0.2	15.1	−0.8	8.5	+0.2
750	12.6	+0.7	8.8	+2.5	12.2	−0.5	4.1	+0.6	14.5	−0.3	7.3	+0.4
1,000	11.2	+0.3	7.1	+1.9	10.9	−0.4	3.1	+0.7	14.2	+0.2	6.0	+0.4
1,250	10.0	+0.2	5.9	+1.7	9.7	−0.3	1.9	+0.6	13.6	+0.4	4.9	+0.6
1,500	8.9	+0.2	4.3	+1.1	8.5	−0.2	0.7	+0.5	13.0	+0.5	3.7	+0.5
2,000	6.4	+0.2	2.3	+1.3	5.7	−0.2	−2.0	+0.2	10.9	+0.5	0.7	−0.1
2,500	3.4	+0.1	−0.6	+1.0	3.0	−0.5	−5.1	−0.2	7.9	+0.2	−2.1	−0.3
3,000	0.5	+0.3	−3.5	+0.9	0.1	−1.0	−8.4	−0.7	4.5	−0.4	−4.6	−0.1
3,500	−2.6	+0.3	−6.4	+1.0	−2.7	−1.3	−11.5	−0.9	1.8	−0.3	−7.0	+0.1
4,000	−5.9	0.0	−9.2	+1.3	−3.9	−0.4	−14.8	−1.1	−1.0	0.0	−8.9	+0.3
4,500	−8.7	0.0	−11.9	+1.6	−7.1	−1.4	−17.8	−1.2	−3.3	−0.3		
5,000	−11.9	0.0	−14.6	+1.9			−20.8	−1.2	−6.0	−0.4		

RELATIVE HUMIDITY (%)

Surface	59	−5	58	−7	65	+4	70	+2	77	+6	64	0
250	59	−5			65	+4			77	+7	64	0
500	56	−7	58	−7	66	+4	69	+2	75	+7	65	+1
750	55	−7	58	−7	66	+3	66	+1	70	+5	65	+2
1,000	53	−7	58	−6	66	+3	65	+2	64	+4	64	+2
1,250	51	−7	57	−6	64	+2	65	+3	58	+3	62	+1
1,500	49	−7	56	−5	62	+2	65	+4	52	+2	63	+3
2,000	49	−3	52	−6	61	+4	64	+5	45	0	71	+13
2,500	52	+1	52	−6	57	+6	66	+8	43	−1	70	+14
3,000	49	−2	54	−3	52	+7	66	+8	45	+3	66	+12
3,500	48	−6	52	−5	49	+9	66	+8	47	+3	68	+9
4,000	46	−5	50	−7	50	+10	64	+6	48	+1	64	+3
4,500	43	−5	48	−9	67	+19	60	+3	42	−1		
5,000	41	−5	46	−9			57	+3	40	−12		

VAPOR PRESSURE (*mb.*)

Surface	10.79	−0.74	7.85	+0.43	11.60	−0.79	6.01	+0.09	15.55	+0.24	8.73	0.01
250	10.66	−0.76			11.42	−0.74			14.86	+0.30	8.57	0.02
500	9.30	−0.81	7.56	+0.49	10.40	−0.38	5.87	+0.12	13.21	+0.41	7.43	+0.08
750	8.18	−0.84	6.78	+0.45	9.49	−0.31	5.30	+0.25	11.84	+0.39	6.91	.31
1,000	7.15	−0.92	6.00	+0.22	8.70	−0.31	4.95	+0.42	10.62	+0.61	6.29	+0.33
1,250	6.37	−0.86	5.36	+0.11	7.68	−0.42	4.54	+0.46	9.27	+0.59	5.78	+0.36
1,500	5.72	−0.73	4.78	+0.02	6.72	−0.38	4.14	+0.47	7.97	+0.65	5.46	+0.54
2,000	4.81	−0.26	3.79	−0.09	5.38	0.00	3.27	+0.33	5.99	+0.35	5.07	+0.99
2,500	4.04	−0.07	3.09	−0.08	4.01	+0.16	2.75	+0.38	4.81	+0.24	4.23	+0.96
3,000	3.20	−0.21	2.56	−0.10	2.83	+0.06	2.23	+0.28	4.16	+0.51	3.40	+0.81
3,500	2.55	−0.41	1.93	−0.25	1.80	−0.27	1.77	+0.17	3.74	+0.67	2.99	+0.76
4,000	1.76	−0.42	1.53	−0.21	0.76	−0.83	1.34	+0.07	3.21	+0.65	2.67	+0.74
4,500	1.37	−0.42	1.23	−0.14	0.66	−0.77	0.97	+0.02	2.58	+0.63		
5,000	1.13	−0.42	1.01	−0.09			0.71	+0.02	2.42	+0.52		

TABLE 2.—*Free-air resultant winds (m. p. s.) during April, 1924*

Altitude, m. s. l. (meters)	Broken Arrow, Okla. (233 meters)				Drexel, Nebr. (396 meters)				Due West, S. C. (217 meters)				Ellendale, N. Dak. (444 meters)				Groesbeck, Tex. (141 meters)				Royal Center, Ind. (225 meters)			
	Mean		Normal		Mean		Normal		Mean		Normal		Mean		Normal		Mean		Normal		Mean		Normal	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Surface	S. 6° W.	1.6	S. 5° W.	2.7	S. 64° W.	2.8	S. 26° E.	0.3	N. 65° W.	1.1	S. 85° W.	1.5	N. 19° W.	1.9	N. 11° W.	1.6	S. 4° E.	1.9	S. 4° E.	2.4	S. 64° W.	1.7	S. 46° W.	2.4
250	S. 5° W.	1.6	S. 6° W.	2.8					N. 64° W.	1.1	S. 84° W.	1.6					S. 7° E.	2.3	S. 4° E.	3.1	S. 66° W.	1.8	S. 46° W.	2.5
500	S. 1° W.	2.8	S. 11° W.	4.2	S. 68° W.	3.2	S. 10° E.	0.4	N. 51° W.	2.1	S. 76° W.	2.6	N. 17° W.	1.9	N. 11° W.	1.5	S.	3.9	S. 4° W.	4.7	S. 58° W.	4.2	S. 44° W.	4.4
750	S. 9° W.	3.5	S. 16° W.	5.2	S. 72° W.	4.7	S. 64° W.	0.6	N. 67° W.	1.6	S. 69° W.	3.3	N. 29° W.	1.3	N. 20° W.	0.9	S. 6° W.	4.2	S. 12° W.	5.3	S. 68° W.	5.5	S. 48° W.	5.8
1,000	S. 21° W.	3.9	S. 27° W.	5.8	S. 74° W.	5.8	S. 68° W.	1.2	N. 87° W.	1.8	S. 63° W.	4.3	N. 64° W.	1.9	N. 50° W.	1.2	S. 31° W.	4.4	S. 24° W.	5.9	S. 68° W.	6.8	S. 54° W.	6.4
1,250	S. 35° W.	4.6	S. 37° W.	6.0	S. 78° W.	7.2	S. 77° W.	2.2	S. 81° W.	2.6	S. 69° W.	6.0	N. 76° W.	3.0	N. 56° W.	1.9	S. 40° W.	4.7	S. 34° W.	6.5	S. 76° W.	8.0	S. 65° W.	7.1
1,500	S. 43° W.	4.9	S. 51° W.	6.7	S. 80° W.	8.4	S. 82° W.	3.2	S. 83° W.	4.8	S. 70° W.	7.3	N. 75° W.	3.7	N. 58° W.	2.5	S. 48° W.	5.8	S. 39° W.	7.2	S. 83° W.	9.6	S. 73° W.	7.8
2,000	S. 61° W.	6.8	S. 61° W.	7.8	S. 89° W.	10.1	S. 89° W.	4.7	S. 86° W.	7.6	S. 80° W.	9.0	N. 81° W.	5.1	N. 72° W.	2.9	S. 60° W.	6.6	S. 50° W.	8.2	S. 87° W.	11.2	S. 82° W.	8.7
2,500	S. 78° W.	8.1	S. 71° W.	8.6	N. 89° W.	12.1	W.	6.6	S. 81° W.	11.4	S. 82° W.	10.7	S. 83° W.	8.5	N. 82° W.	4.6	S. 69° W.	7.3	S. 58° W.	9.1	N. 85° W.	13.0	S. 86° W.	9.1
3,000	S. 85° W.	10.1	S. 81° W.	8.8	N. 77° W.	12.6	N. 87° W.	9.1	S. 79° W.	7.8	S. 85° W.	10.8	N. 86° W.	10.4	N. 80° W.	6.2	S. 71° W.	9.0	S. 63° W.	11.2	N. 80° W.	12.3	S. 87° W.	10.9
3,500	S. 82° W.	11.8	S. 85° W.	11.8	N. 79° W.	12.5	S. 89° W.	10.7	W.	16.4	N. 85° W.	12.2	S. 87° W.	11.2	N. 84° W.	7.8	S. 71° W.	10.3	S. 70° W.	10.6	N. 86° W.	13.2	S. 80° W.	12.0
4,000	S. 85° W.	11.2	S. 82° W.	12.8	W.	11.8	N. 87° W.	12.6	S. 89° W.	20.8	N. 75° W.	14.7	S. 77° W.	11.7	N. 82° W.	8.6	S. 85° W.	11.8	S. 83° W.	12.8	N. 86° W.	17.4	S. 85° W.	13.5
4,500	S. 76° W.	13.3	S. 76° W.	15.6	N. 85° W.	15.5	N. 78° W.	13.8	N. 68° W.	22.8	N. 50° W.	15.2	S. 88° W.	8.6	N. 69° W.	8.1	S. 85° W.	13.4	S. 79° W.	14.0	N. 45° W.	15.1	S. 87° W.	11.2
5,000	S. 77° W.	15.2	S. 77° W.	15.2	N. 86° W.	18.8	N. 84° W.	17.5					W.	18.2	N. 74° W.	16.3	S. 79° W.	15.5	S. 85° W.	14.6				